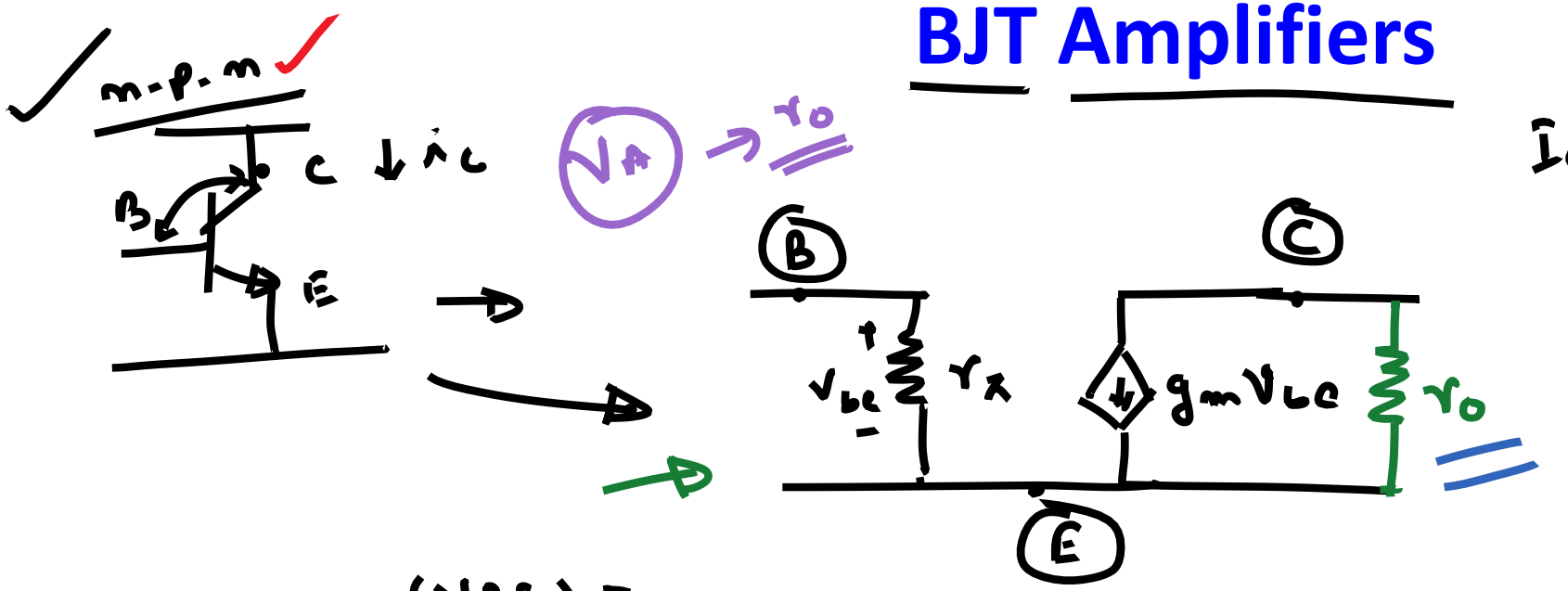
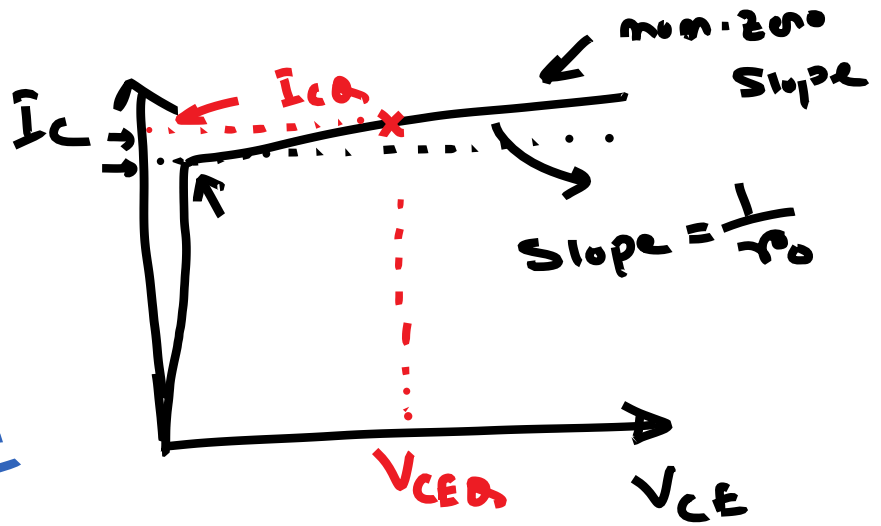
BJT Amplifiers





$i_C = I_S \exp\left(\frac{V_{BE}}{V_T}\right)\left[1 + \frac{V_{CE}}{V_A}\right]$; V_A = Early voltage $\simeq$ 200 - 300V.

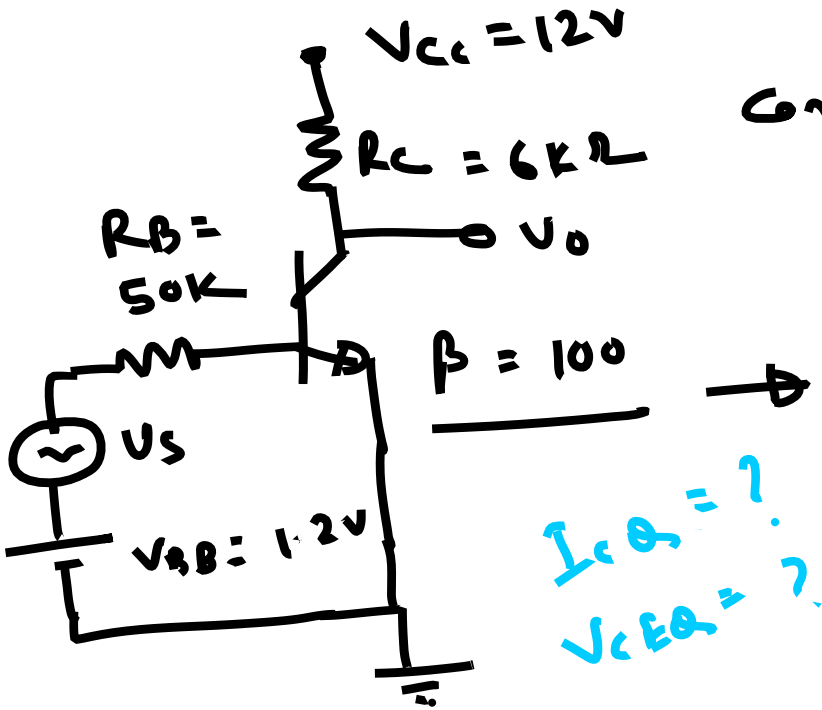
$\frac{1}{r_o} = \frac{\partial i_C}{\partial V_{CE}}\Big|_{Q\text{-pt}} = \frac{I_S \exp\left(\frac{V_{BE}}{V_T}\right)}{V_A} \simeq \frac{I_{CQ}}{V_A}$ ✓

$r_o = \frac{V_A}{I_{CQ}}$ → Small Signal transistor o/p resistance

if V_A is finite, then consider r_o.

if $V_A \to \infty$, $r_o \to \infty$, don't consider r_o.

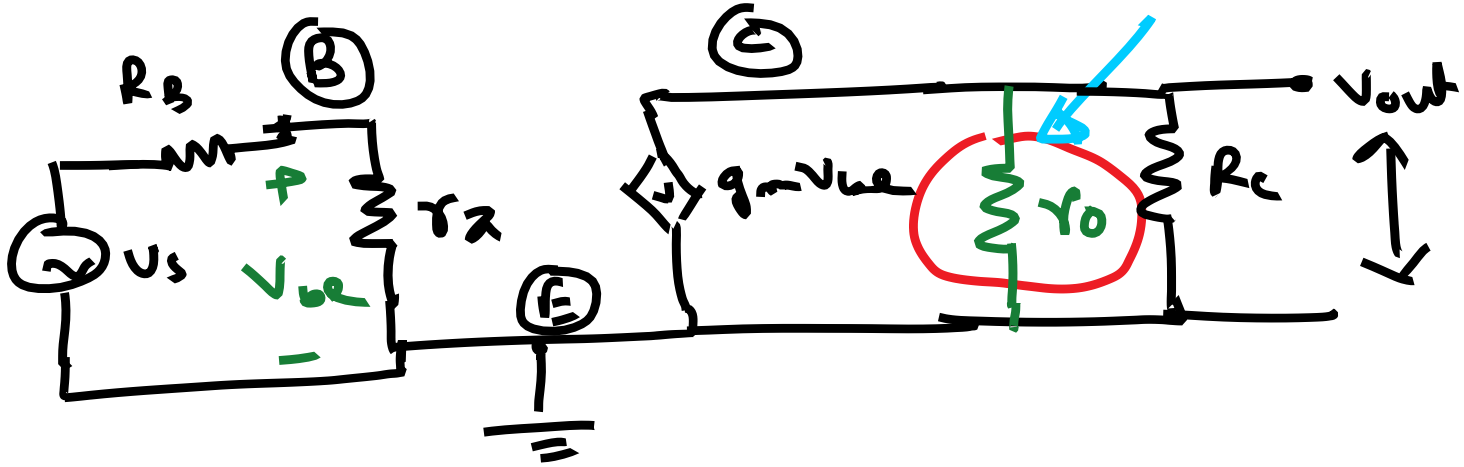
BJT Amplifiers



$I_{CQ}=?$

$V_{CEQ}=?$

Consider the effect of 'r_o'



$V_A=50V.$

$r_o=?$

$A_v=-10.2$

$V_{out}=-g_m V_{be}(r_o \| R_C)=$ $\quad R_C > R_C \| r_o$

$V_{be}=V_s\times\frac{r_\pi}{R_B+r_\pi}$

$V_{out}=-g_m\underbrace{(R_C \| r_o)}_{(R_C)}\times V_s\times\frac{r_\pi}{R_B+r_\pi}$

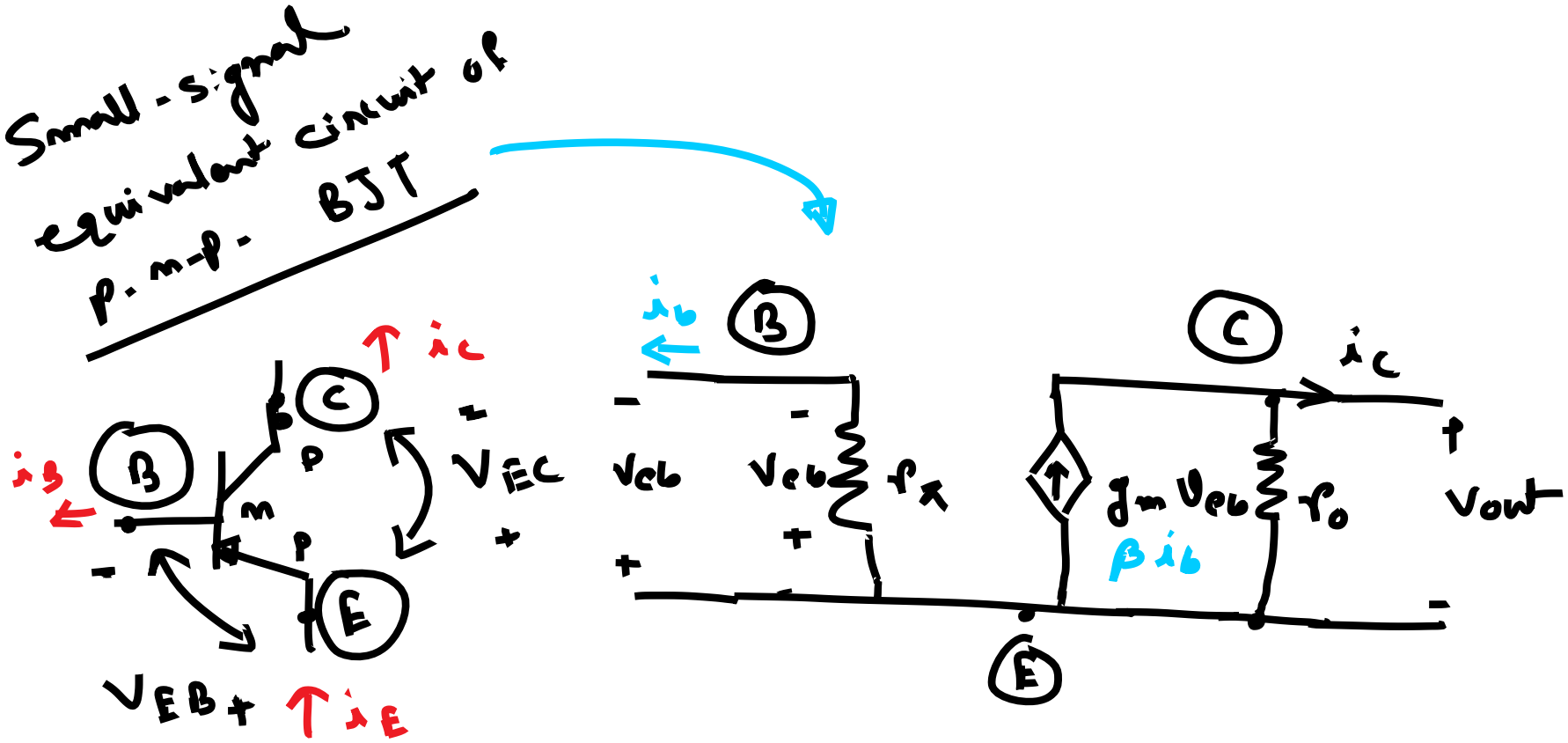
??

$\text{gain}=\frac{V_{out}}{V_{in}}=\frac{-g_m(R_C \| r_o)\times\frac{r_\pi}{R_B+r_\pi}}{}$; gain reduces

Small signal

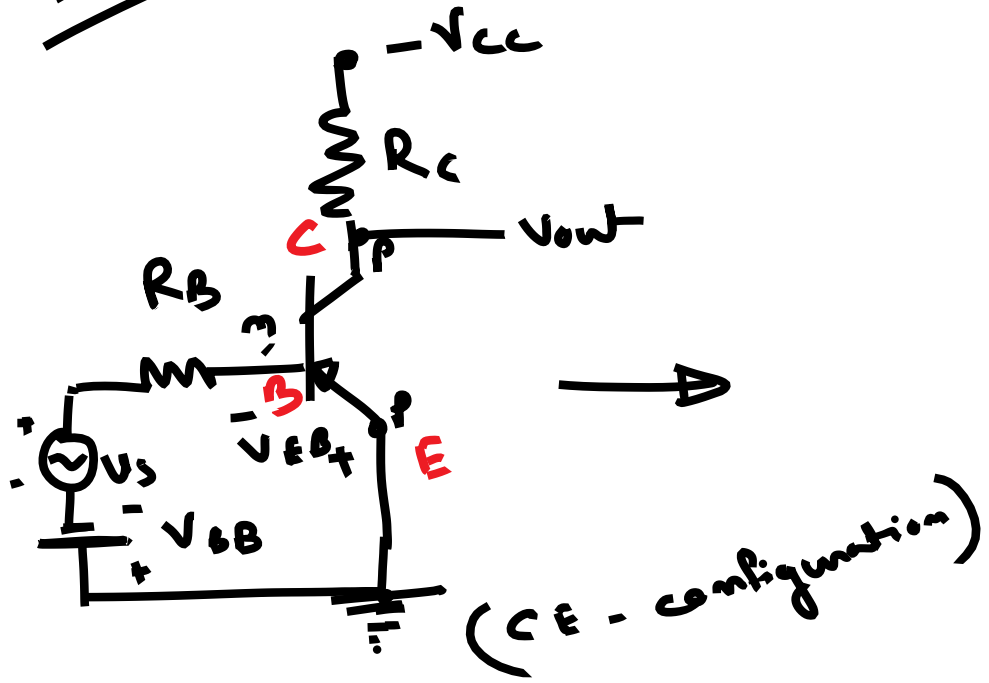
BJT Amplifiers

Small-signal equivalent circuit of p-n-p BJT

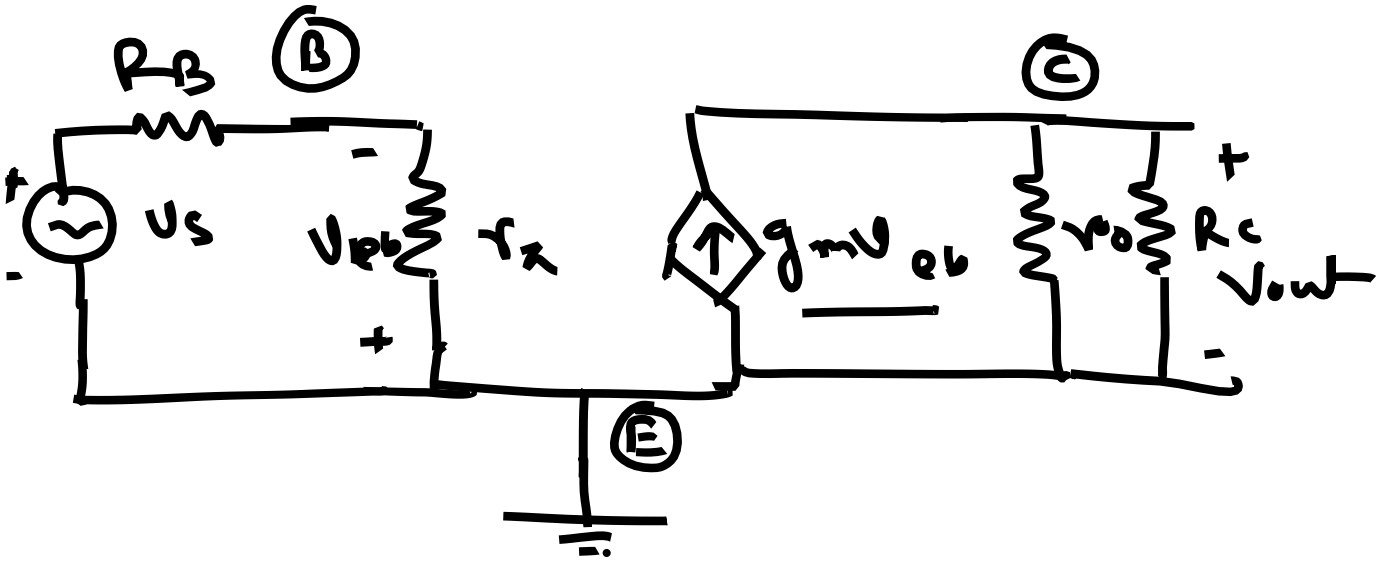


BJT Amplifiers

P.N.P



(CE - configuration)



$$V_{out} = g_m V_{BE} (R_c \| r_o)$$

$$V_{BE} = -V_s \times \frac{r_\pi}{R_B + r_\pi}$$

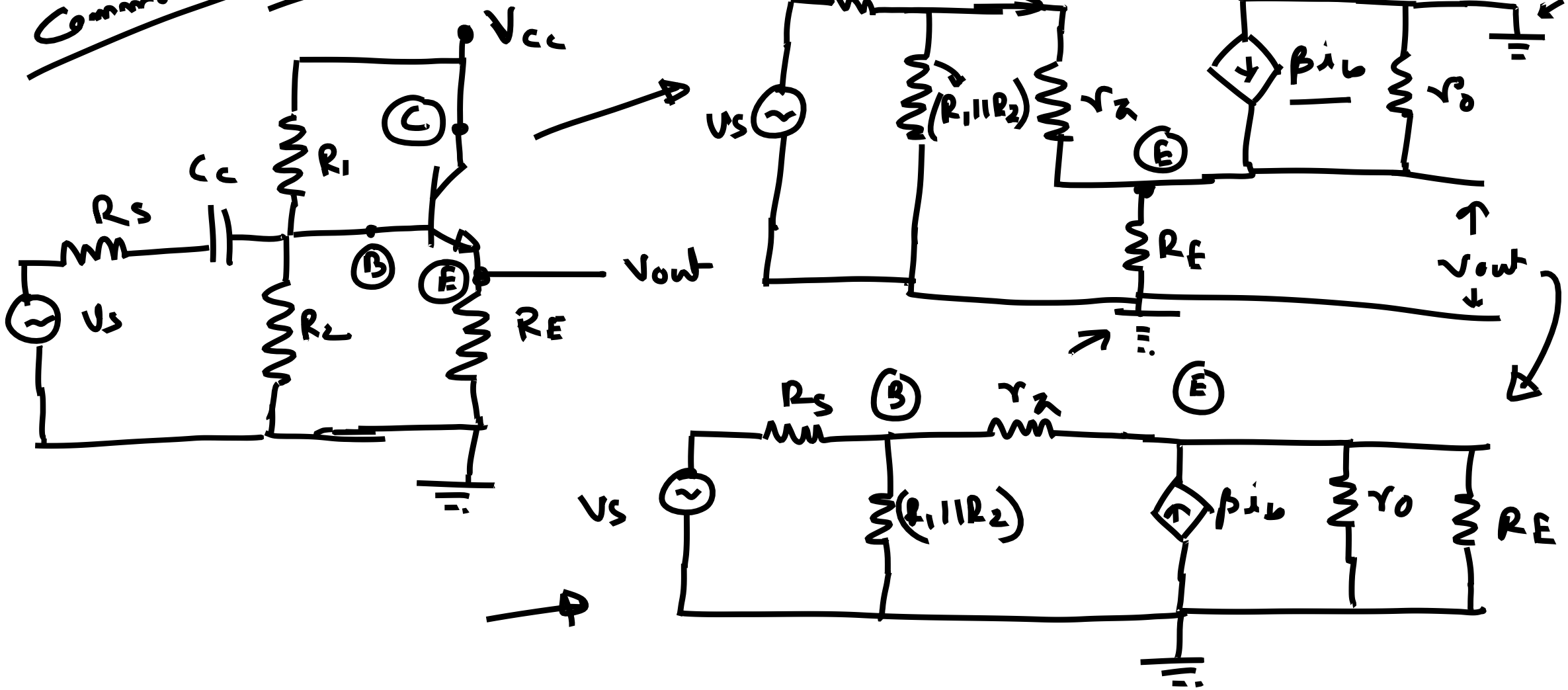
$$\therefore V_{out} = -g_m (R_c \| r_o) \times \frac{r_\pi}{R_B + r_\pi} V_s$$

$$\therefore \text{gain} = \frac{V_{out}}{V_s} = -g_m (R_c \| r_o) \frac{r_\pi}{R_B + r_\pi}$$

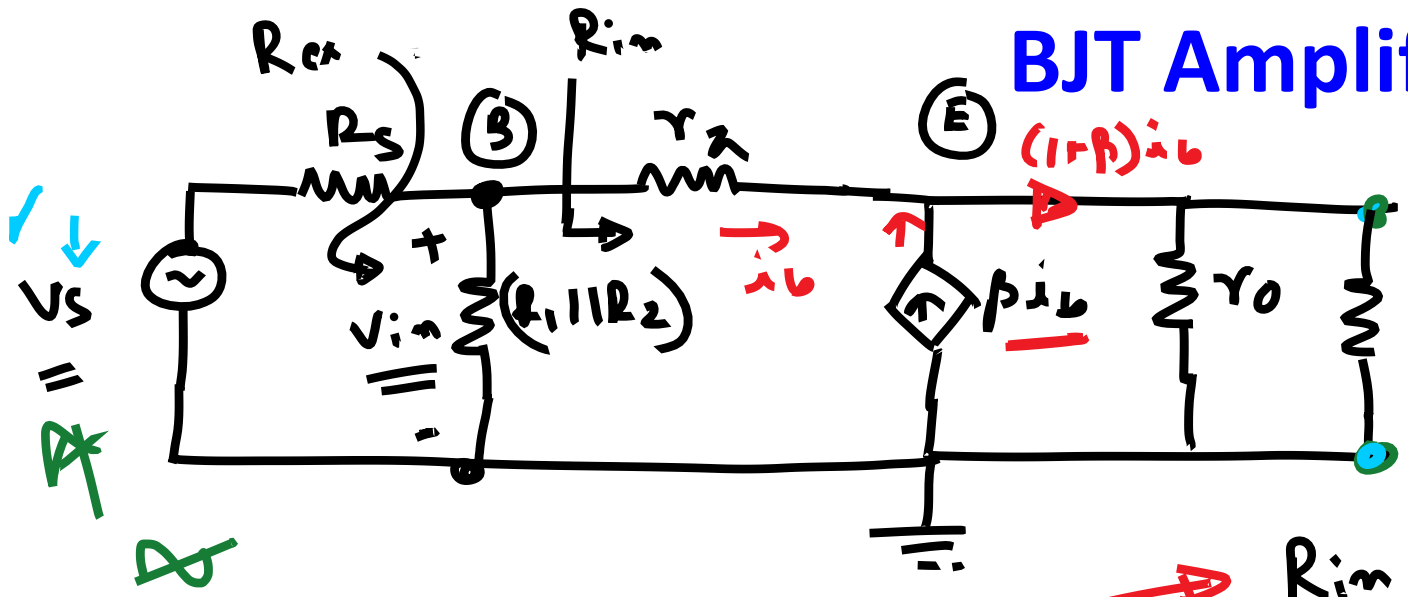
BJT Amplifiers

(CC Amp)

Common Collector Amplifier



BJT Amplifiers



(C-C Amp)

$V_{out} = i_b (1+\beta)(R_E \| r_o)$

$V_{in} = i_b r_\pi + (R_E \| r_o)(1+\beta) i_b$

$R_{in} = \frac{V_{in}}{i_b} = r_\pi + (R_E \| r_o)(1+\beta)$

$R_{ex} = R_1 \| R_2 \| R_{in}$

$V_{in} = V_s \times \frac{R_{ex}}{R_s + R_{ex}} = i_b r_\pi + (R_E \| r_o)(1+\beta) i_b$

$\Rightarrow i_b = V_s \times \frac{R_{ex}}{R_s + R_{ex}} \times \frac{1}{r_\pi + (R_E \| r_o)(1+\beta)}$

$V_{out} = V_s \times \frac{R_{ex}}{R_s + R_{ex}} \times \frac{1}{r_\pi + (R_E \| r_o)(1+\beta)} \times (1+\beta)(R_E \| r_o)$

$\text{Gain} = \frac{V_{out}}{V_s} = \left(\frac{R_{ex}}{R_s + R_{ex}}\right) \times \left(\frac{(1+\beta)(R_E \| r_o)}{r_\pi + (R_E \| r_o)(1+\beta)}\right)$ (<1) (<1)

① Gain ≃ 1

$\frac{R_{ex}}{R_s + R_{ex}} \simeq 1$

C.C. Amp. ⇐ ??

② Emitter Follower

C.C. Amp: input resistance high, o/p resistance low, gain positive

③

Gain < 1

④